

Human Reliability and the Cost of Doing Business

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Abstract:

Most businesses recognize that people will make mistakes and assume errors are just part of the cost of doing business, but does it need to be? Companies with high risk, or major consequences, should consider the effect of human error. In a variety of industries, Human Errors have caused costly failures and workplace injuries. These have included: airline mishaps, medical malpractice, mistakes in the administration of medication and major oil spills have all been blamed on human error. A technique to identify (in order to mitigate or even eliminate) some of these costly human errors is the use of Human Reliability Analysis (HRA).

Various methodologies are available to perform Human Reliability Assessments these range from simply identifying the most likely areas for concern, to detailed assessments where human error failure probabilities are calculated. Which methodology to use would be based on a variety of factors that include: 1) how people react and act in different industries, and differing expectations based on industries standards, 2) factors that influence how the human errors could occur such as tasks, tools, environment, workplace, support, training and procedure, 3) type and availability of data and 4) how the industry views risk & reliability influences (types of emergencies, contingencies and routine tasks versus cost based concerns). The Human Reliability Assessments should be the first step to reduce, mitigate or eliminate costly mistakes or catastrophic failures.

Using Human Reliability techniques to identify and classify human error risks allows a company more opportunities to mitigate or eliminate these risks and prevent costly failures.

Introduction:

Not all errors are a problem, some interesting and important discoveries have been made when the unexpected happens. People are capable of flashes of brilliance and heroic saves as well as instances of boneheaded actions and massive stupidity, most human actions fall somewhere in between. Most people go to work intending to do a good job, but people make mistakes. As complexity is added to how we work and the tasks and actions associated with that work, the opportunities to make mistakes are not only increased but often set up individuals for failure. Work processes and mechanical system designs are not inherently safe and generally do not consider the human interface as part of their design, inadvertently setting people up for failure. Just as safety needs to be designed into the system, so do features to help people succeed. Failures associated with people working with systems or processes are generally identified as human errors. It makes sense that if we lower the incidence of human errors, we lower the failure rate.

Human Reliability and the Cost of Doing Business

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Human Reliability can be described as the degree to which humans performing the same action would arrive at the same result, that being the desired result (i.e. no error) following the prescribed action. When discussing human error, there are a number of interpretations that can be used. Generally, just using the word error has negative connotations. Most people accept that making errors is a natural result of being human, thus the desire to replace humans with automation, which is expected to do repetitive tasks exactly the same way without deviation or “error”. Human Reliability Analysis or Assessment is the term used for qualitative and quantitative methods used to assess the human contribution to risk.

Human error has been cited as the cause of accidents in every industry. These errors can have relatively low cost such as printing twenty copies instead of one or more dramatic cost impacts like the bank clerk who inadvertently transferred \$293 million from the bank to a private account. Accident investigations and risk assessments often identify human error as major contributors to the accident. Looking back over the last few years provides a number of examples of accidents or disasters attributed to human error in multiple industries including oil & gas, nuclear power, airlines, aerospace, medical , finance and transportation that have cost millions.

The problem from the perspective of cost:

In business, the bottom line is cost and safety. Mistakes arising from human error or human reliability can result in process failures, manufacturing down time, loss of life or physical injuries, facility damage and other areas that affect business costs.

Is it good business practice to have a plan to mitigate human errors, or is it a better business move (similar to assumed theft costs in retail stores) to have contingency funds or planned cost assumption for human error? Many companies have taken the position that you cannot eliminate all human errors, so why try. Others take the position that it's more cost effective to address an issue after it has been shown to be a problem. Alternatively, companies who proactively lower their incidence of human error could see a long term cost savings with reduced shutdowns, accident occurrences and workforce costs.

Some examples of the costs where the failure has been attributed to human error include:

- BP estimated that the Deepwater Horizon oil spill resulted in costs exceeding \$40 billion.
- Airports have estimated that ramp accidents have cost over \$10 billion.
- More than a decade ago, the Institute of Medicine issued a study on medical error identifying 44,000 - 98,000, preventable deaths occur annually due to medical errors in U.S. hospitals. In the last 10 years, this has been estimated to exceed 200,000 preventable deaths in the last few years.
- Preventable errors undercut quality, safety, IT security and customer service. These incidents decrease profits and drain resources at every level of an organization, creating waste and negating the effectiveness of training, processes and procedures.

Human Reliability and the Cost of Doing Business

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- There are estimates that large companies lose tens of millions of dollars because of employees who misunderstood or misinterpreted company policies, business processes, job functions—or a combination of the three.
- IT security studies show that most data breaches are caused by human error. Surveys have shown that many employees do not think they are responsible for protecting corporate information and believe that restrictions on use of social media (long known to be a security risk) in the workplace are outdated and unnecessary.
- Transportation accidents attributed to Human Error have included train derailments and large truck accidents, attributed to operator or driver error.
- Workforce costs include property damages, worker injuries, lost work days, increases in insurance premiums and fatalities.

Even after suffering these losses, many managers prefer to address the accident as an isolated incident. Their logic appears to be that human error is inevitable and therefore a systematic review and assessment is not cost effective. Decisions are often based on perception rather than analysis, and business decisions may be focused on what happens today and discount what might happen in the future. Further compounding the problem is the failure to consider low-probability/high-consequence events, especially when the probability of occurrence may not be assessed at all.

Addressing the Issue:

Human error occurs regularly, and there are endless opportunities to make mistakes. One thing to remember is that these are unintended errors, which can result in limited or no impact or they can result in a spectacular failure event. The purpose of human error control is to reduce human induced failures.

Generally, the first thought for addressing a potential human error is to remove the human from the equation. Replacing people with automated systems works well for repetitive systems or when a prescribed action must be performed in very short periods of time. However, when decisions or flexibility is needed, the human is often the only choice.

Changing machine or system designs to ensure that the machines do not allow human error is another mitigation method. However, this option is often either impractical or not cost effective. This leaves the option of assisting individual to perform tasks faultlessly. The use of work instructions or operating procedures is generally designed for this purpose. Unfortunately, the theory “if you followed directions exactly, you wouldn’t have had a problem”, has not been proven valid. Additionally, adding more rules often has the unplanned result of adding more complexity and the gap between procedure and practice widens instead of narrows and often results in more errors rather than fewer.

You need to “understand the problem”, be able to identify, define, and develop scenarios consistent with what can occur and why. Keys to understanding Human Error and performing an assessment of Human Reliability include:

Human Reliability and the Cost of Doing Business

D.L. DeMott

SAIC – Sr. PRA/HRA Analyst

- Understanding the context, operator actions and potential failures or errors specific to the scenario the human is expected to operate within
- Careful review of associated procedures and operations to determine where human errors could occur
- Understanding how all characteristics of the system or process are expected to interact (system, component, software, procedures, human behavior and instrumentation)
- Identifying potential failures and the consequences to determine which are risk-significant
- Attempt to reflect the following characteristics in any assessment of a scenario identified as high risk:
 - System behavior and conditions
 - timing of events and the occurrence of human action cues
 - parameter indications used by the operators and changes in those parameters as the scenario proceeds
 - time available and locations necessary to implement the human actions
 - equipment available for use by the operators based on the sequence
 - environmental conditions under which the decision to act must be made, and under which the actual response must be performed
 - degree of training, guidance, and procedure applicability
- Remember.... The operator is often “set-up” for failure and the operator is often on the “sharp end” simply because they are the last one to touch “the problem”.

Human errors are not random or isolated breakdowns, but rather are the result of the same processes that allow a system’s normal functioning. The following lists the types of errors expected for Human Error assessments.

- Errors of omission and commission
- Slips/lapses, mistakes, and circumventions
- Skill-, rule-, and knowledge-based errors
- Information processing models, such as:
 - Detection
 - Situation assessment

Understanding the issues and consequences surrounding a potential human error event, provides management with the tools needed to determine the cost effectiveness of attempting to eliminate or mitigate the potential error or accepting the consequences and associated costs of doing nothing. To improve human reliability does not mean you need to go through all the steps and labor intensive methodologies that are needed to support a quantitative risk assessment. For certain high risk, high consequence situations this may make sense, but for other issues a modified approach using certain basic concepts can be used to help mitigate either the risk of the error occurring or lessen the consequences if it does occur.

Human Reliability and the Cost of Doing Business

D.L. DeMott

SAIC – Sr. PRA/HRA Analyst

Methodologies:

Human Reliability Assessment is like many other tools, there are several ways to do it, and there is no single methodology that fits all possible needs. There are certain basic elements that contribute to identifying and resolving potential human errors. As in most instances of problem solving, you need to 1) identify the problem, 2) identify the cause and 3) mitigate or eliminate the cause. The following elements provide some basic tools to help identify where the potential problems could occur and the underlying cause of the potential Human Error. These tools are less manpower intensive and detailed that the more rigorous quantitative risk methodologies:

1. Task analysis to identify where potential human errors could occur
2. Expert elicitation of what could go wrong and how humans can cause or contribute to the event
3. Process flow assessments can identify areas that encourage misunderstandings or mistakes
4. Question and response methodologies elicit information from those who know where to look for the problem areas
5. Models, flowcharts and decision trees will organize and provide a pictorial representation of the activities

For more meticulous and comprehensive methodologies, Human Error analysis or Human Reliability Assessments (HRA) is generally based on two general classes. Cognitive theory tends to be more qualitative, while Probabilistic Risk Assessment (PRA) combines qualitative and quantitative aspect resulting in failure probabilities. In a qualitative risk model, the model is a visual representation of basic events and how they combine to produce an undesired outcome. This shows the inter-relation between equipment failures, human error, and at-risk behaviors that can combine to produce the undesired result. The methods listed in the table below provide repeatability and traceability when assessing the potential human error risks (both qualitative and quantitative).

Example HRA Methodologies Table

Acronym	Full Name	Developed By	Date
CREAM	Cognitive reliability and error analysis method (based on COCOM)	Hollnagel, E.	1998
THEA	Technique for Human Error Assessment	Pocock, et. al	2000
CBDT	Caused Based Decision Tree Method		
HERA	Human Error Repository and Analysis (HERA) project	NRC, (Hallbert et al.)	2006

Human Reliability and the Cost of Doing Business

D.L. DeMott

SAIC – Sr. PRA/HRA Analyst

THERP	Technique for Human Error Rate Prediction	NRC (Swain & Guttman)	1983
SPAR-H	Standardized Plant Analysis Risk (SPAR) Human Reliability analysis method	NRC (NUREG/CR-6883.)	2005
ATHEANA	A Technique for Human Error Analysis	NRC	1996
	Human Error HAZOP	Whalley	1988
SPEAR	System for Predictive Error Analysis and Reduction	CCPS	1993
HEART	Human Error Assessment and Reduction Technique	Williams	1986

Other Factors:

When something goes wrong, the easiest explanation is to attribute the cause to human error. This becomes the explanation without further need for details and alleviates the need to address “fix” the problem immediately, unlike causes attributes to mechanical or design problems. The results can often be categorized as:

- Punish the individual who made an error and create remedial training
- Emphasize accountability
- Create team strategies and improve communication
- Put multiple layers of policy and procedural protection in place
- Introduce cultural approaches

People act and react differently, and have different expectations based on experience, training, industrial cultures, personal standards and company expectations. Other factors influencing how people react include: age, physical condition, health, state of mind, attitude, biases, emotions and expectations.

Human errors happen for a variety of reasons. It's easier to follow a familiar path, or how it was done before regardless of the changes in circumstances. Or conversely, humans may find a new path that they perceive as easier. If you “follow the procedures, rules and regulations” any errors that occur are “not your fault”. Misinterpreting what they see, hear or read. And even though we know distractions are likely to result in errors, people still attempt to multi-task.

Identifying the potential areas and causes for human error is the first necessary step in addressing concerns. The next step is for management to choose to eliminate, mitigate or accept the risk.

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Summary and conclusions:

Human error cannot be defined unambiguously in advance of it happening, it often becomes an error after the fact. The same action can result in a tragic accident for one situation or a heroic action given a more favorable outcome. People often forget that we employ humans in business and industry for the flexibility and capability to change when needed. In complex systems, operations are driven by their specifications of the system and the system structure. People provide the flexibility to make it work.

Human error has been reported as being responsible for 60%-80% of failures, accidents and incidents in high-risk industries. We don't have to accept that all human errors are inevitable. Through the use of some basic techniques, many potential human error events can be addressed. There are actions that can be taken to reduce the risk of human error.

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HUMAN RELIABILITY AND THE COST OF DOING BUSINESS

Introduction

- Not all human errors are a problem
- People can perform heroic saves but also behave with massive stupidity, most people and human actions fall somewhere in between.
- Most people go to work intending to do a good job
- Human Reliability is the degree to which humans perform the same action and arrive at the same desired result
- Human error has been cited as the cause of accidents in every industry and has been shown to cost millions

The perspective of cost

Some examples of the costs where the failure has been attributed to human error include:

- Deepwater Horizon estimated costs exceeding \$40 billion.
- Airports ramp accidents estimated cost over \$10 billion.
- Current estimates of preventable deaths due to medical errors ~200,000 per year
- Estimated losses of large companies due to employees misunderstandings or misinterpretation are in the range of millions of dollars
- Majority of IT security data breaches are attributed to employee errors in understanding of internet and computer protection measures
- Train derailments and large truck accidents generally attributed to operator or driver error.
- Workforce costs include property damages, worker injuries and fatalities.

Addressing the Issue

- Options
 - Remove the human
 - Modify the machinery
 - Take action to identify, define and act on the problem
- Understanding the Problem
 - Understanding the context
 - Review all associated information
 - Understanding system or process and interactions
 - Identifying potential failures and consequences
 - High risk scenarios to consider:
 - System behavior and conditions
 - Timing of events and the occurrence of human action cues
 - Parameter indications used by the operators and changes in those parameters as the scenario proceeds
 - Time available and locations necessary to implement the human actions
 - Equipment available for use by the operators based on the sequence
 - Environmental conditions under which the decision to act must be made and the actual response must be performed
 - Degree of training, guidance, and procedure applicability

Addressing the Issue

- Types of human errors
 - Errors of omission and commission
 - Slips/lapses, mistakes, and circumventions
 - Skill-, rule-, and knowledge-based errors
 - Information processing models, such as:
 - Detection
 - Situation assessment
- Understand risk
 - Issues
 - Consequences
- Actions based on potential risk
 - Eliminate
 - Mitigate
 - Accept

General Methods

- One methodology does not fit all
- Basic problem solving:
 - Identify problem
 - Identify cause
 - Mitigate or eliminate cause
- Basic tools to help identify potential problem areas:
 - Task analysis to identify where potential human errors could occur
 - Expert elicitation of what could go wrong and how humans can cause or contribute to the event
 - Process flow assessments can identify areas that encourage misunderstandings or mistakes
 - Question and response methodologies elicit information from those who know where to look for the problem areas
 - Models, flowcharts and decision trees will organize and provide a pictorial representation of the activities

Specific Methodologies

- Human Reliability Methodologies are generally based on two concepts:
 - Cognitive theory tends to be more qualitative
 - Probabilistic Risk Assessment (PRA) approaches combine qualitative and quantitative aspects
- Examples of Currently used Methodologies
 - CREAM – Cognitive Reliability and Error Analysis Methodology
 - THEA – Technique for Human Error Assessment
 - CBDT – Caused Based Decision Tree Method
 - HERA – Human Error Repository and Analysis Project
 - THERP – Technique for Human Error Rate Prediction
 - SPAR-H – Standardized Plant Analysis Risk Human Reliability Analysis Method
 - ATHEANA- A Technique for Human Error Analysis
 - Human Error HAZOP
 - SPEAR – System for Predictive Error Analysis and Reduction
 - HEART- Human Error Assessment and Reduction Technique

Other Factors

- The easiest explanation for an accident is human error.
- Most common responses are:
 - Punish the individual who made an error and create remedial training
 - Emphasize accountability
 - Create a team strategies and improve communication
 - Put multiple layers of protection in place
 - Introduce cultural approaches
- Factors influencing how people react include:
 - Age & experience
 - Health & physical condition
 - State of mind & attitude
 - Biases & emotions
 - Expectations

Other Factors

- Common reasons given:
 - It's easier to follow a familiar path
 - It's easier to follow a perceived easier path
 - If you follow the rules it's not your fault.
 - Misinterpretations
 - Multi-tasking
- First step is identifying the potential areas and causes for human error
- Next step management action

Summary

- Human error has been reported as being responsible for 60%-80% of failures, accidents and incidents in high-risk industries.
- People provide the flexibility to make something work and react to unexpected situations. They can also cause the problem or make it worse.
- Human error often becomes an error after the fact
- Don't have to accept that all human errors are inevitable
- There are options